Citation:

Song WO, Chun OK, Kerver J, Cho S, Chung CE, Chung SJ. Ready-to-eat breakfast cereal consumption enhances milk and calcium intake in the US population. *J Am Diet Assoc.* 2006 Nov; 106 (11): 1,783-1,789.

PubMed ID: 17081829

Study Design:

Cross-sectional study

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To establish the association between the intake of ready-to-eat breakfast cereal (RTEC), milk and calcium within the context of the most current population dietary practices. Researchers hypothesized that RTEC consumption facilitates milk consumption and is associated with adequacy of calcium intake in the US population.

Inclusion Criteria:

- Participation in the National Health and Nutrition Examination Survey (NHANES)
- US residents
- Age four years or older.

Exclusion Criteria:

Pregnant or lactating women.

Description of Study Protocol:

Recruitment

- Data used in this study were from the most recently released NHANES dataset
- Participation and recruitment into NHANES was reported elsewhere and not done by these researchers.

Design

Cross-sectional study (using recently released ongoing NHANES datasets 1999 to 2000).

Dietary Intake/Dietary Assessment Methodology

For the NHANES study, breakfast, RTEC and milk consumption data were collected, including questions on actual consumption of milk poured on cereal; only milk actually consumed was subsequently included in the data analysis.

Statistical Analysis

- All data analyses were carried out using SAS software (release 8.1, 2000, SAS Institute Inc, Cary, NC) and the Survey Data Analysis for multistage sample designs professional software package (SUDAAN, release 8.0.2, 2003, Research Triangle Institute, Research Triangle Park, NC)
- Variance approximation was calculated with the Jackknife procedure. Specifically, the leave-one or JK-1 procedure was used to estimate sampling errors because the primary sampling unit variables were not released in NHANES 1999 to 2000. Jackknife is often used in non-survey applications involving clustered data. The most common Jackknife method for sample surveys is to delete one primary sampling unit. The sampling fraction in a first-stage stratum is the number of primary sampling units selected in the sample divided by the population number of primary sampling units in the stratum
- Multiple regression analyses were performed to determine the extent to which calcium intake was explained by breakfast and milk and RTEC consumption. Regression coefficients and standard errors were estimated after adjustment for age and ethnicity. Statistical significance of the effects of breakfast, milk and RTEC consumption was determined using the Wald F test
- Means and standard errors for all nutrients examined were calculated by the Jackknife procedure using PROC DESCRIPT in SUDAAN. The means for RTEC consumers and RTEC nonconsumers were tested for statistically significant differences using T-tests in PROC DESCRIPT of SUDAAN
- SUDAAN was used to increase the accuracy and validity of the results through computing variance estimates and test statistics for a stratified, multistage probability survey design. Sample weights were applied to all analyses to account for the unequal probability of selection, non-coverage and non-response bias resulting from over-sampling of low-income persons, adolescents, elderly persons, African Americans and Mexican Americans.

Data Collection Summary:

Timing of Measurements

One-time data collection (NHANES database used for this study).

Dependent Variables

Daily energy and nutrient intake including:

- Energy (kcal per day)
- Energy from protein (percent per day)
- Energy from fat (percent per day)
- Energy from carbohydrates (percent per day)
- Fiber (g per day)
- Magnesium (mg per day)
- Phosphorus (mg per day)
- Zinc (mg per day)
- Iron (mg per day)
- Vitamin A (RAEe per day)
- Vitamin E (mg per day)
- Thiamin (mg per day)
- Riboflavin (mg per day)
- Niacin (mg per day)
- Vitamin B_6 (mg per day)
- Vitamin B_{12} (mg per day)
- Folate (mg per day)
- Vitamin C (mg per day).

Independent Variables

Consumption of ready-to-eat breakfast cereals.

Description of Actual Data Sample:

- *Initial N:* 7,403 total (772 were four to eight years old and excluded from the sex, age and ethnicity breakdowns)
- *Attrition (final N):* Excluding the 772 who were four to eight years old and not reported in the sex and ethnicity breakdown, there were 6,631 subjects
- *Age:* Four years old and older
    - 772 were between four and eight years old
    - 1,101 were between nine and 13 years old
    - 1,314 were between 14 and 18 years old
    - 878 were between 19 and 30 years old
    - 1,324 were between 31 and 50 years old
    - 1,291 were between 51 and 70 years old
    - 723 were 71 years or older
- *Ethnicity:* Of the 6,631 respondents nine years or older
    - 2,352 were white

- 1,538 were African-Americans
- 2,198 were Hispanic
- 543 were marked "Other"

- *Location:* United States.

Summary of Results:

- Children aged four to eight years were found to have a distinctive amount and pattern of RTEC and milk consumption. Therefore, this sub-group was excluded from the calculation of mean calcium intake and from the multiple regression analyses
- Breakfast consumers tend to be older and white ($P \leq 0.01$)
- The highest prevalence of breakfast consumption was found among four- to eight-year-old children (93.5%), adults older than age 71 years (92.1%) and white (79.3%)
- The sub-groups of breakfast consumers reporting the lowest levels of RTEC consumption were men aged 19 to 30 years (12.4%) and women aged 31 to 50 years (15.8%)
- For all breakfast consumers age nine years or older, 95% of RTEC breakfast consumers consumed milk with RTEC
- RTEC breakfast consumers had significantly higher nutrient intake than non-RTEC breakfast consumers for all nutrients examined except energy intake from fats
- RTEC breakfast consumers who consumed RTEC with milk showed significantly higher nutrient intake than those who consumed RTEC only for calcium, riboflavin, vitamin B_6, B_{12} ($P \leq 0.01$) and niacin ($P \leq 0.05$)
- For all respondents age nine years or older, mean intake of calcium at breakfast was 50mg from RTEC and 276mg from milk. For the same respondents, mean intake of calcium during a 24-hour period was 50mg from RTEC and 436mg from milk. RTEC was predominantly consumed at breakfast, and calcium intake from breakfast among breakfast consumers that included RTEC and milk in their breakfast meal was seven times the calcium intake of breakfast consumers that included RTEC, but not milk, in their breakfast meal (345 vs. 50mg)
- Multiple regression was used to predict total daily calcium intake and breakfast consumption, milk with RTEC and milk without RTEC were all significant predictors for daily calcium intake ($P \leq 0.05$) after controlling for age and ethnicity
- The percent of RTEC consumers with calcium intake above US Adequate Intake (AI) ranged from 13.6% to 72.3% across age and sex sub-groups
- Increased consumption of RTEC was associated with lower prevalence of dietary inadequacy of calcium in all age and sex categories except girls aged nine to 13 years.

Author Conclusion:

Researchers concluded that consumption of RTEC at breakfast was associated with greater daily intake of both milk and calcium in all age and sex groups in the US population.

Reviewer Comments:

Research partially funded by the Kellogg company, one of the largest ready-to-eat cereal companies in the United States.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A

3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	No
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes

6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	N/A
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	N/A
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes

8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes